Abu Alanda Housing Competition

PART (1): Design and Research Idea:

Main Conceptual Statement

Rethinking sustainability and humanity in our approach to ecological architecture and affordable housing centering on efficiency in everyday practice and a unique built landscape aesthetics were appearance is shaped by ideas of ecological performance and the built environment is intelligently integrated into the landscape.

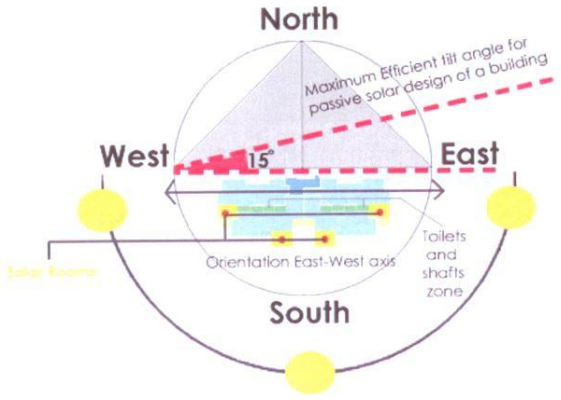
The building design adopts a holistic and all-inclusive system that incorporates occupants as participants in energy and water efficient everyday practices. A reciprocal model promoting a more interactive role between occupants and nature where both form an ecosystem of shared dependency.

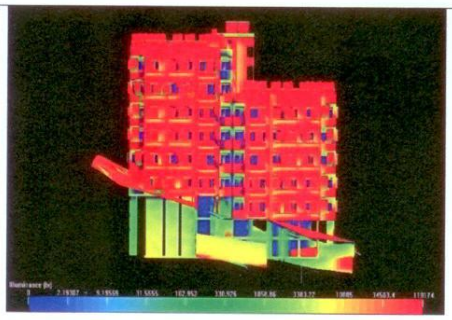
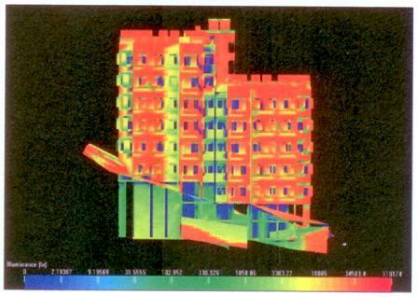
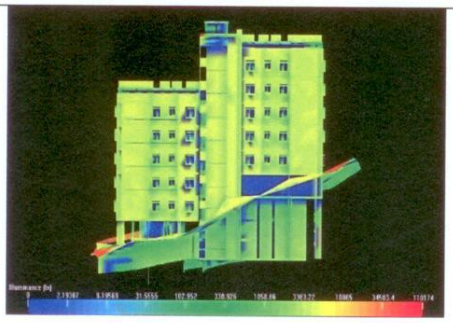
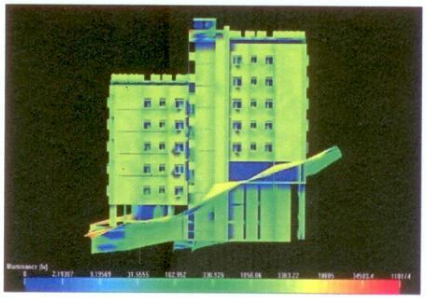
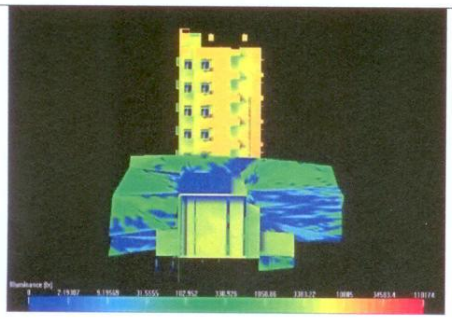
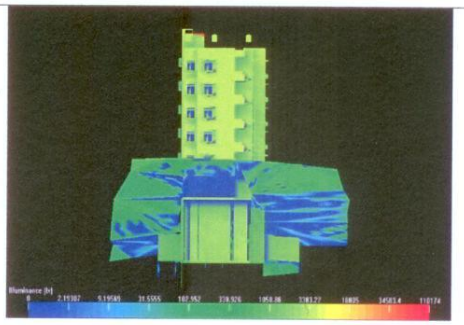
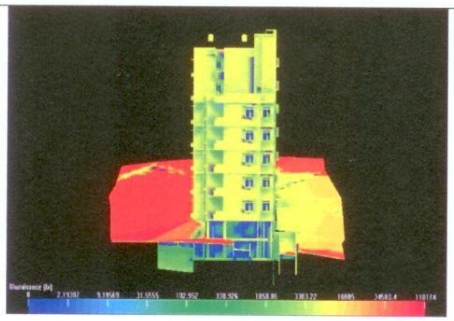
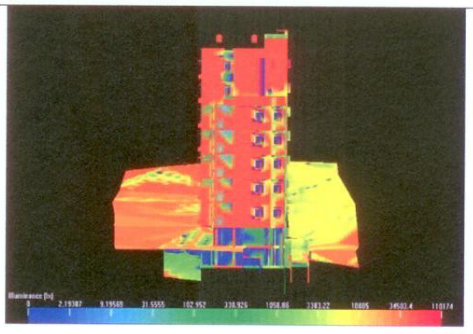
The starting point was to maximize the use of passive design for conserving energy and water in buildings and the site as a whole. At the building scale, several issues were taken into consideration such as:

- **Orientation:** the buildings were oriented to face south and stretched longitudinally on an East-West axis while living rooms of all 4 apartments in any floor enjoyed southern exposure.

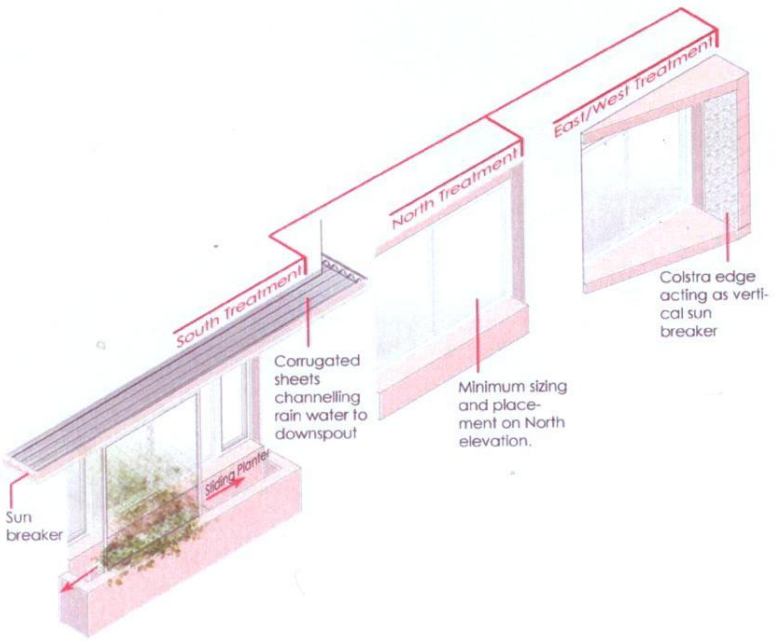
- **Mass Compactness:** the design made best use of the steep land and located parking within the structure of the building instead of locating it within setbacks which would have infringed on natural terrain. Parking is accessed from the lower street level. Each building is composed of two shifting vertical units based on their placement on different land plots; each unit is composed of two apartments on each floor.

- **Zoning of functions within each apartment:** Each apartment has its own living room and balcony facing south with a glass area that enables it to trap more heat during winter. winter. Balconies offer a breathing space for occupants, emphasizing the idea of bringing nature into the house especially with the sliding plant screens that act as vertical gardens. The bathrooms are aligned linearly opening up to adjacent shafts for ventilation reducing plumbing costs.

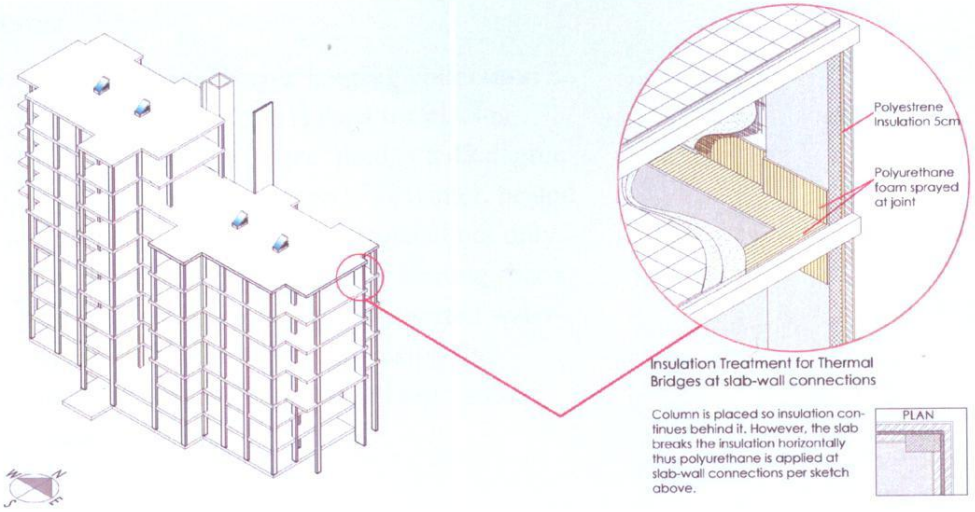


Time and Date	Illustration of energy distribution on building facades in winter, Dec, 21st.	
	12 pm (noon)	8 am (morning)
South façade		
North façade		
West façade		
East façade		

-Sizing and design of window units corresponding to each façade: the southern façade… is distinct for using clear glass windows with sun breakers and sliding plant screens that moderate summer and winter temperatures. During summer, the sliding screens could be be placed in front of the window creating shade and cooling effect, while during winter it could be slid aside to allow more sun to penetrate the space, the plants are selected to be deciduous. Eastern and Western windows use clear glass and have a *colstra* edge that act as a vertical sun breaker. On the northern facades; windows form an insulating units, limited in number and area (area=53m2 versus 216m2 on the southern side).



-Construction method, materials and insulation treatments: The building structure is a fly-ash concrete post and beam system, and the exterior wall infill is composed of double hollow concrete block, polystyrene insulation in between and stucco as an outer finish layer. Several treatments are proposed for solving thermal bridges at certain locations. (Refer to diagram below). The roof and other exposed floors are insulated with 5cm polystyrene. The internal walls of the apartments are made of papercrete; Papercrete is a green material of paper recycled content, and could be produced through a community development project to generate income for local residents and to contribute to the sustainable development of the community and environment.



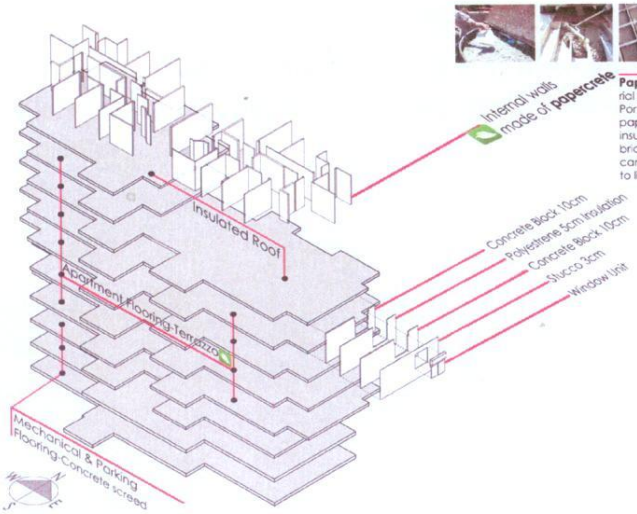
Insulation Treatment for Thermal Bridges at slab-wall connections

Column is placed so insulation continues behind it. However, the slab breaks the insulation horizontally thus polyurethane is applied at slab-wall connections per sketch above.

PLAN

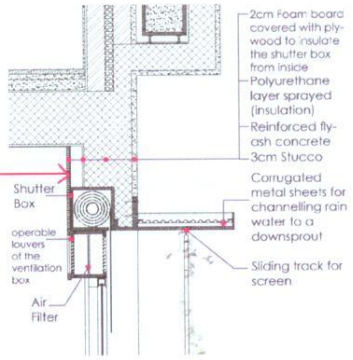
Internal walls made of **papercrete**

Papercrete is a building material comprised of a mixture of Portland cement and recycled paper fiber — a light-weight, insulating concrete, forming bricks after being sun-dried. It can be plastered and finished to liking.



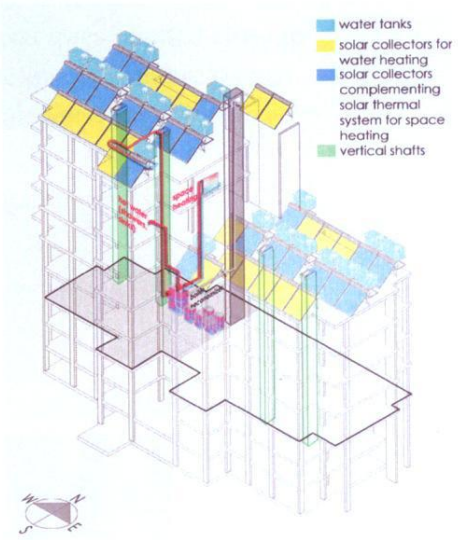
Post and Beam structural system of reinforced fly-ash concrete

Insulation Treatment for Thermal Bridges at shutter box over window by adding a 2cm foam panel from the inside.

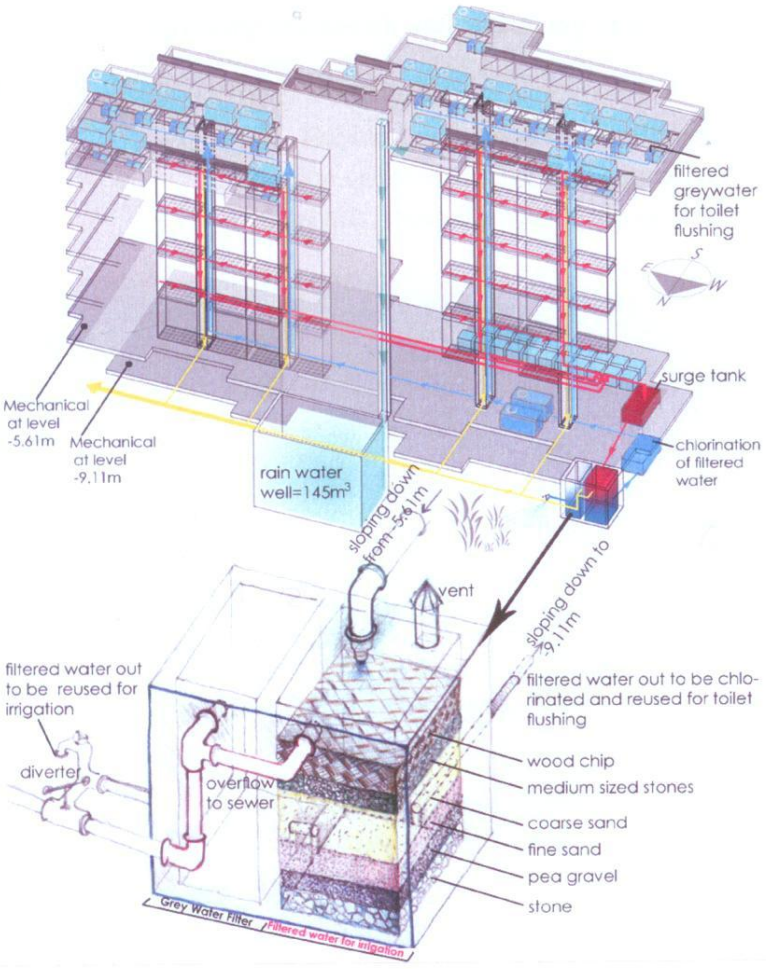


-Systems:

- **Solar thermal water heating collectors:** The whole roof area is used for placing solar collectors that are tilted at a 47 degree angle (optimal for winter). At winter, heated water by solar panels is circulated not only for domestic use, but also for heating space through radiators where solar heated water is fed into boilers thus decreasing fuel amounts needed to heat relatively colder water.



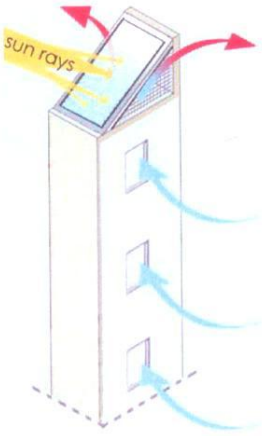
- **Greywater Reuse System:** greywater is filtered for the irrigation of ornamental plants only in the outdoor areas, and further filtered by chlorination for toilet flushing.



- **Landscaping:** landscaping proposes a harmonious integration between soft and hard landscaping which include deciduous that include deciduous trees planted close to southern facades, evergreens planted at western facades acting as windbreakers, bioswales and holding areas along pervious surfaces for rainwater retention.

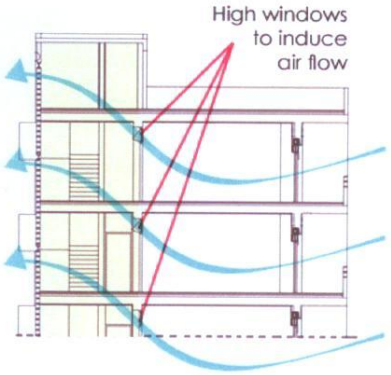
-Improving the health and wellbeing of occupants:

- Proper ventilation:
  - The use of shafts as solar chimneys: passive solar heating of the air at the top of the shafts induces natural ventilation for toilets opening into the shafts; thus eliminating the need for fans.

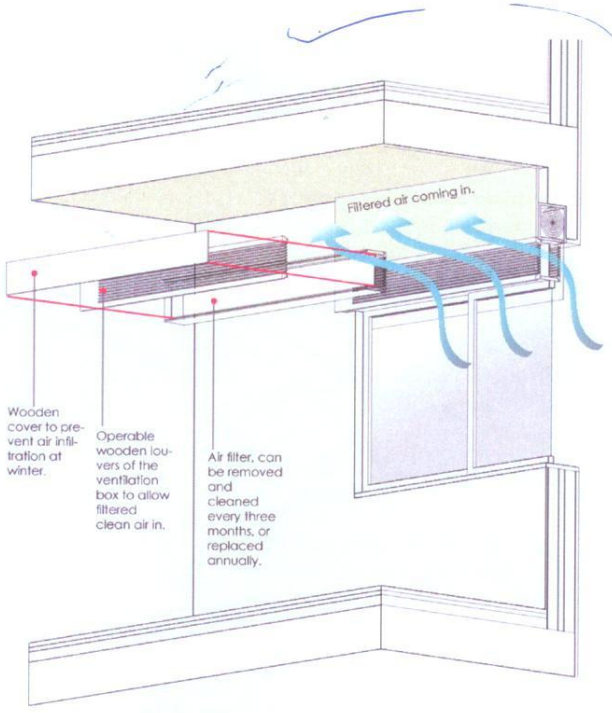


  - Passive Cross ventilation in each apartment is created by opening high windows on top of main entrance door of each apartment to create air flow

through the vertical structure of the stair case acting here as a wind tower too.



- Ventilation box offering clean air: The idea of using air filtering boxes came as a response to the fact that the site is next to an old stone quarry. Also, vertical gardens that run the full height of the southern façade assist with shading, glare and air quality.

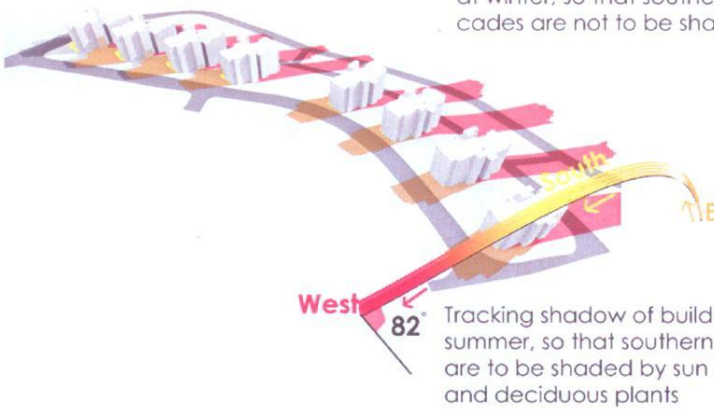


-Instilling a sense of belonging and commitment to the environment: Sustainability emphasizes a symbiotic living between humans and nature. This is accomplished by providing shared open spaces for local residents to interact and for children or for kids to play. It is vital to engage the community on a practical level to appreciate the environment by offering collection areas for recyclables and informing them not to use harsh chemicals to ensure an efficient greywater reuse system.

At the site scale, the relationship between the buildings stirred a series of design decisions which included:

-Side setbacks are to be increased (to 20m) between the first 4 plots to provide the apartments of each building southern solar exposure at winter pertinent to to be used for heating. This increase came in parts taken from the middle green shared garden to be distributed as intermediate smaller gardens shared between buildings.

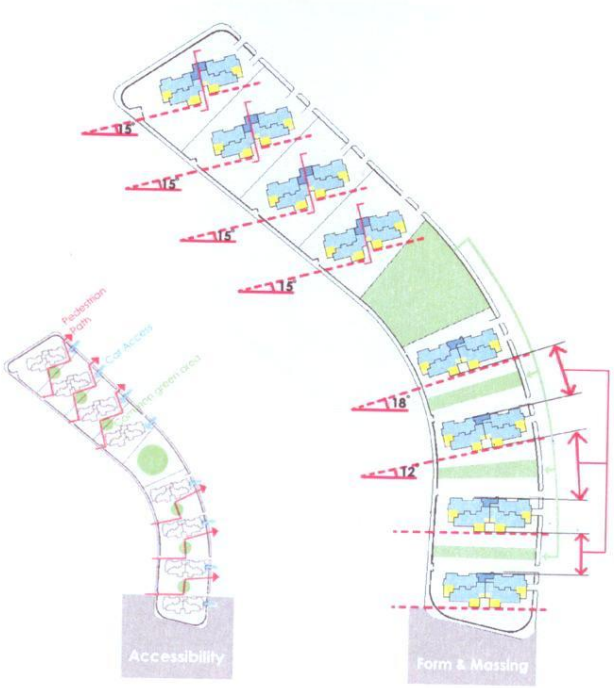
Tracking shadow of buildings at winter, so that southern facades are not to be shaded.



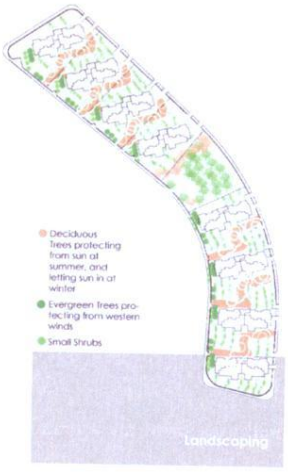
Tracking shadow of buildings at summer, so that southern facades are to be shaded by sun breakers and deciduous plants

-The buildings are optimally designed to respect the shape of their plots and simultaneously harness winter solar sun. They are dynamic in which some buildings

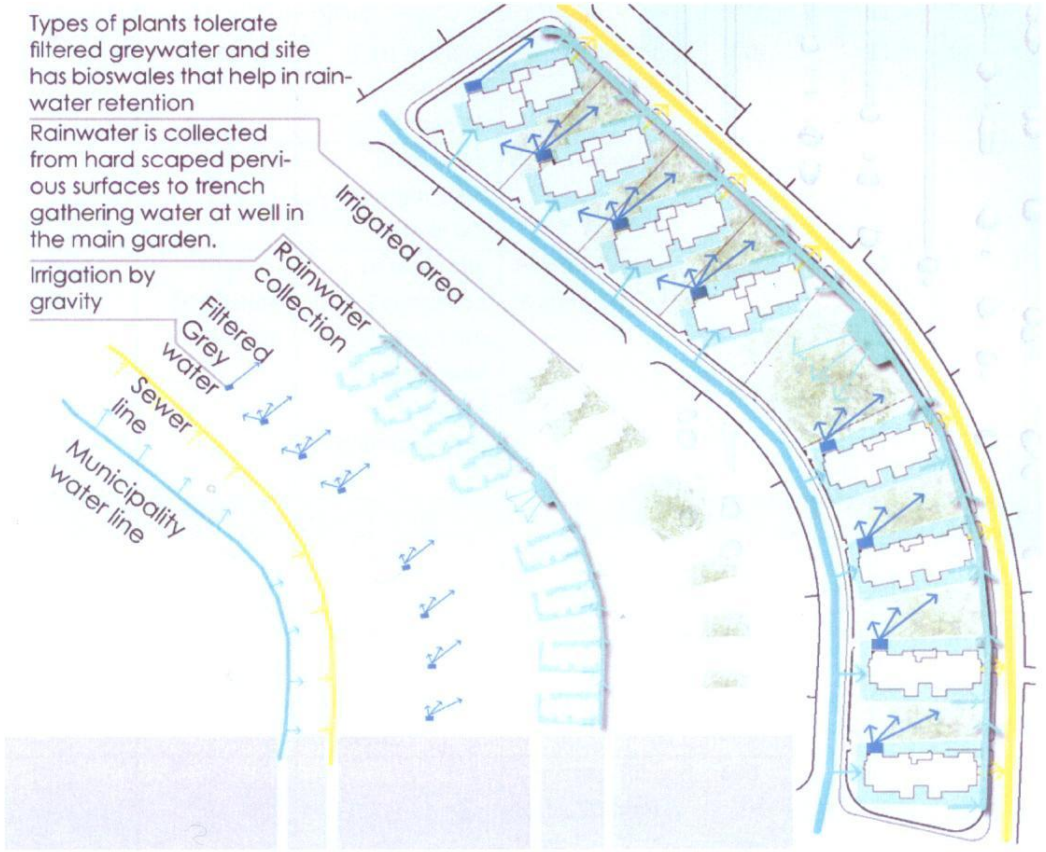
rotate to a maximum of 15 degrees from south while others have their vertical units sliding horizontally.



-Water conserving Landscapes were integrated at site scale



-A comprehensive approach to water conservation was used at site scale, utilizing filtered greywater from buildings to irrigate plants by gravity (without needing pumps), and harvesting rainwater runoff from the hard landscaped surfaces of the site to be collected by a trench at the lower street leading to a water well at the main intermediate garden to be used for irrigation.



PART (2): Cost estimate for the construction of the apartment building:

Category	Description	Description	Description	Quantity	Unit	Rate	Amount
						JD	JD
Substructure	Site Work	Excavation	For Foundation & Ground Leveling	10700	m3	3	32100
		Filling		6000	m3	2	12000
	Concrete	Cast-In-Place Concrete Grade 25	Foundation	100	m3	66	6600
	Steel	Steel (High Strength Steel Grade 60)	Foundation				10000
	Thermal &Moisture protection	To cover the Foundation surfaces With Cold Fluid Applied Waterproofing	Polyurethane Waterproofing	400	m2	7	2800
Total							**63500**
Superstructure	Concrete	Concrete	Various Diameters				
		Concrete Grade 15	Blinding	510	m2	5	2550
		Concrete Grade 25	Landing	110	m3	66	7260
			Concrete Ribbed Slabs, 250mm thick	690	m3	66	45540
			Columns	50	m3	66	3300
			Concrete walls 250mm thick	300	m3	66	19800
			Lintels, size 1000x200mm	60	m3	66	3960
		Steel	Steel (High Strength Steel Grade 60)	300	Ton	720	216000
	Masonry	Concrete Masonry Unit	Hollow Concrete Block, 100mm thick	3450	m2	5	17250
			Hollow Concrete Block, 200mm	300	m2	7	2100

			thick				
			Paper Crete (internal walls), 100mm thick	2850	m2	4	11400
			Ribbed Concrete Blocks,	25200	No	0.30	7560
			Collestra Concrete block, 200*400*200 mm	350	m2	6	2100
	Thermal &Moisture protection	Polystyrene Panels 500mm thick	Vertically For external walls	100	m3	80	8000
			Horizontally For the roof	30	m3	80	2400
		Cold Fluid Applied Waterproofing	Polyurethane Waterproofing For the surfaces around the slab	1450	m2	7	10150
		Foam Panels	On the surface of the Shutter & ventilation boxes	180	m2	5	900
Total							**360270**
Finishes	Finishes	Stucco Plaster	External Walls	2200	m2	12	26400
		Portland Cement Plaster	Internal Walls	10230	m2	7	71610
	Metals & woods	Steel doors	Double Leafs	2	No	300	600
			Single Leaf	9	No	120	1080
		Wood doors	Single Leaf	159	No	160	25440
		Aluminum windows	Single glazed 8mm, for the south, west and east elevations	350	m2	42	14700
			Glass Type B: Insulating Glass Unit Composed of : Outer Pane (6mm clear glass), Air Space (12mm), Inner Pain(6mm clear low-E (Pilkington)	53	m2	53	2809

		Paint	Using type *Low VOC*	11050	m2	3	33150
		Ceramic Tiles	Size 200mmx200mm x5mm thick	1210	m2	10	12100
		Portland Cement Terrazzo	Size 300mmx300mm x30mm thick	4100	m2	6.5	26650
		Aluminum Shutter & ventilation boxes	Over all the windows	121	No	115	13915
		Plant Screen	For the south elevation	61	No	110	6710
		Ivy Walls	For the North elevation	500	m2	17	8500
Total							**243664**
Landscaping	External Paving	Including Base Course	Interlock cement Paving, size 150x65x65 mm	400	m2	10	4000
	Trees& Plants	Obtained from Ministry of agriculture Free of Charge					0.00
	Site Work	Excavation	For steps and Terraces	700	m3	3	2100
		Filling	For steps and Terraces	500	m3	2	1000
		Concrete	In steps and Terraces and walls	180	m3	100	18000
		Stone Gabions, 300mm thick	In steps and Terraces	320	m2	23	7360
		Staircases & Steps & Ramps		130	mr	25	3250
	Solar Powered Outdoor Lighting	DC system off-grid		50	No.	320	16000
Total							**51710**
M&E	Mechanical Installation	Plumbing & Sanitary Installation using *LOW FLUSH BATHROOM FIXTURES*		Lump Sum			88800

		Solar Thermal Water Heating System (using 4 Solar Collectors)		21	No	500	10500
		Grey Water Re-Use System					15000
		Electric Traction Elevator (820Kg, , 12 Person/speed 1.5m/sec.		1	No	24500	24500
	Electrical Installation	*USING ENERGY SAVING LIGHTING FIXTURES*		Lump Sum			63000
		Central Satellite System		1	No	1500	1500
Total							**203300**
Summery							
Substructure							**63500**
Superstructure							**360270**
Finishes							**243664**
Landscaping							**51710**
M&E							**203300**
Total							**922444**

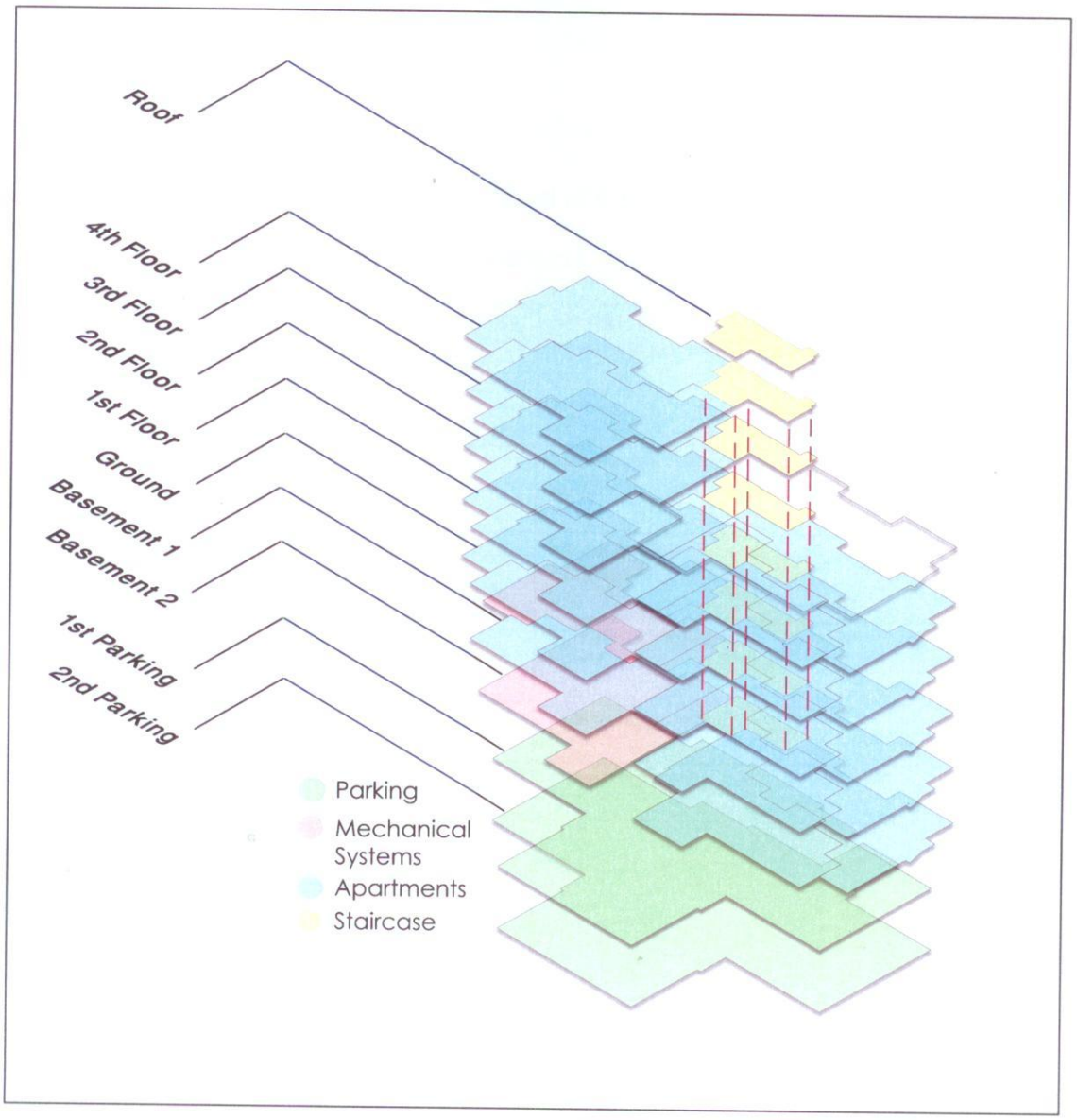
Total cost estimate per-square-meter for the apartment building=

922444 JD **/ 4005** m2 (total area of building) = **230.30 JDs/m2**
which is less than the proposed limit of 235-240 JDs/m2

Building Zones and Areas

Floors	Function	Area	FAR Included	FAR Excluded
Parking 1	Stair Case	18.5	*	
	Parking	531.45		*
Parking 2	Stair Case	18.5	*	
	Parking	417.2		*
	Water Tank	31		*
Basement 1	Stair Case	28	*	
	Mech. Area for Grey Water S.	188		*
	2 Apartments	2(120)	*	
Basement 2	Stair Case	28	*	
	Grey Water Space + Diesel Tanks	65		*
	Boiler	29.5	*	
	3 Apartments	3(120)	*	
Ground	Stair Case	28.7	*	
	4 Apartments	4(120)	*	
1st	Stair Case	28.7	*	
	4 Apartments	4(120)	*	
2nd	Stair Case	28.7	*	
	4 Apartments	4(120)	*	
3rd	Stair Case	25.2	*	
	2 Apartments	2(120)	*	
4th	Stair Case	25.2	*	
	2 Apartments	2(120)	*	
Roof	Stair Case	18.5	*	
			Total=2772.3 m2	1232.65 m2

Allowable built up area = Area of plot (1575.22) x 1.76 = 2772.4 m2
Total Area included in FAR = 2772.3 m2
Total Building area = 4005 m2


Roof
4th Floor
3rd Floor
2nd Floor
1st Floor
Ground
Basement 1
Basement 2
1st Parking
2nd Parking
Parking
Mechanical Systems
Apartments
Staircase

PART (3): Life Cycle Cost Analysis for the building for 20 years

Assumption: The household is composed of 6 people

The building is composed of 21 households.

	Material Or System	Initial Cost JDs per building	Maintenance Cost	Savings per household per year	Payback Period in years (initial cost/savings) per building	Environmental Impact
Materials	**Stucco**	25200	None	Maintenance cost saved		Sustainable material (less carbon footprint)
	Papercrete	11400	None	Saving if it were concrete block		Recycled Content (less carbon footprint)
	Insulation (polystyrene,)	8000 + 2400=10400		81% energy saving		Energy conserving
	Polyurethane at edges	10150		13.5% energy saving		Energy conserving
	Foam at shutter box	900		75% energy saving		Energy conserving
	Ventilation box	6957.5	Changing air filter or can be substituted by a sponge and washed periodically by inhabitants= 50JDs every 2 years per household			Health and wellbeing of inhabitants
	Low VOC paint inside	33150	Repainting every 3years= 90JDs per household			Health and wellbeing of inhabitants
	Glazing-south,	6000		80% energy saving	2 years	Energy conserving
	Glazing north	2809		20% energy saving	4.5 years *	
	Plant Screens-summer (cooling)	6710	Painting every 2years (61 x 10JDs)=610 610x10=6100 in 20 years	51 JDs for 5 months of the year as cooling energy saving	(6710 + 6100/ (51x21)=12 years	Energy conserving
	Doors	25440	Maintenance every 10 years = 159 door x 15JDs = 2385 per building			

	Windows	17509	Maintenance every 10years = 8060 JDs per building			
Water	**Water saving devices**	8400	Maintenance every 5years=60 JDs	Water amount Saving 30% = saving 27.36m3 = 27JDs	8400/567=14.8 years	Water conserving
	Rain water harvesting features Water well and rain channels			Saving 7m3 of water = 7JDs		Water conserving
	Grey water Filtering System for toilet flushing	15000	Maintenance every 6 months=200JDs	Saving 60m3 of water for toilet flushing = 60JDs	15000 + 8000 (maintenance for 20 years/ (60x21)= 18 years	Potable Water conserving
	Grey water Filtering System for irrigation			Saving 3.8m3 which is around 4JDs		Potable Water conserving
Total water cost saved per household per 20years	**98 JDs/household x 21 x 20years= 41160 JDs saved per building for 20 years = 41160 m3 of water**					
Energy	**Solar water heater**	At 47 degree tilt angle 7035 JDs	Maintenance every 5 years=50JDs per household	30% energy saving = 72JDs	3 years	Energy conserving
	Solar thermal water heater (auxiliary system to boiler)	3150	Maintenance every 3 years=75JDs per household	Saving 398.87 L of diesel= 200JDs per household per year	5 years	Energy conserving
	Solar Powered Outdoor Lighting	16000	Replacement every 14years	If normal lamps were used instead, electricity consumption for 20 years would be=7200JDs	16000+16000/7200=4.4 years	Energy conserving
	Electrical system (energy saving lighting)	63000	Maintenance every 2 years=60 JDs per household	Energy bill saving Saving 50% = 84JDs	63000+12600/ 35280 (savings)= 2.1 years	Energy conserving
Total electricity saved per household	**Typical consumption (20JDs/monthx12x20)=4800JDs. Saved amount=1440+1680=3120 Utility bill for 20years per household=4800-3120=1680 JDs Utility bill saved for outdoor lighting per household as a shared cost = 6800JDs in 20 years**					

per 20years						
Operating Building Equipment	**Elevator**	24500	200 JDs per year			Comfort of inhabitants
	Central Satellite System	1500	Maintenance every 3 years=75 JDs per building	Versus installing 21 dishes with extensions (50JDs per dish for 21 apt.=1050JDs) No saving here, but it is aesthetically and environmentally more responsible	Aesthetic value (less visual pollution), roof area utilized for solar collectors, no cable extension outside the building which increases air infiltration	Less carbon footprint (by reducing the number of dishes and utilizing the roof area for harvesting sun rays)

- Shared expenses – irrigation saving water for plants by greywater = 200m2 (planted area) x 20l/week =4000l/week = 16m3/month = 16 x 5(dry months of the year)= 80m3 saved for the building. i.e. 80/21=3.8m3 per household which is around 4JDs per household.
- Shared expenses for maintenance of equipment in 20 years = 4000 (elevator) + 500 (satellite) = 4500JDs per building For a household, it would incur=214JDs in 20years

Typical Consumption

Typical electricity bill per household per month: 20 JDs

Typical water bill per household per month: 70L/person x 6x30days=12.6m3 per household = 13JDs

Typical Diesel consumption per year: 340 JDs

Our Building:

Resultant electricity bill per household per month: 1680/21/12=7JDs

Per year=84JDs

Resultant water bill per household per month: 70L/person x 6x30days=13JDs -8 JDs (savings)= 5 JDs

Per year=60JDs

Resultant Diesel consumption per year: 340-200JDs (savings)= **140 JDs**

Total Operation Cost per household each year=**284 JDs**

Total Maintenance Cost per household each year=**231.5 JDs**